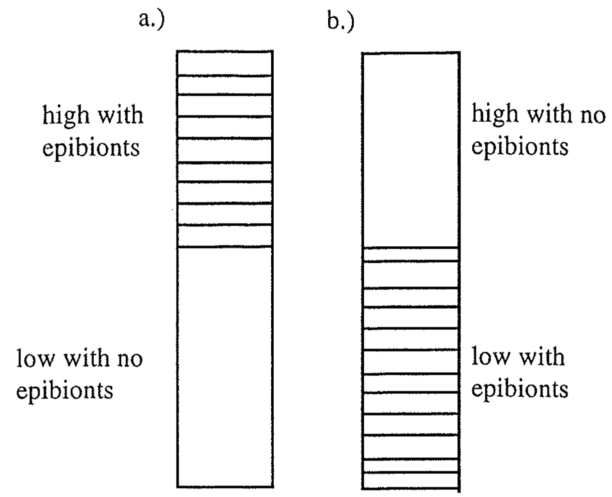

Figure 1. a.) Treatment with epibionts only on the top portion of the blade (normal). b.) Treatment with epibionts only on the bottom portion of the blade (reversed).

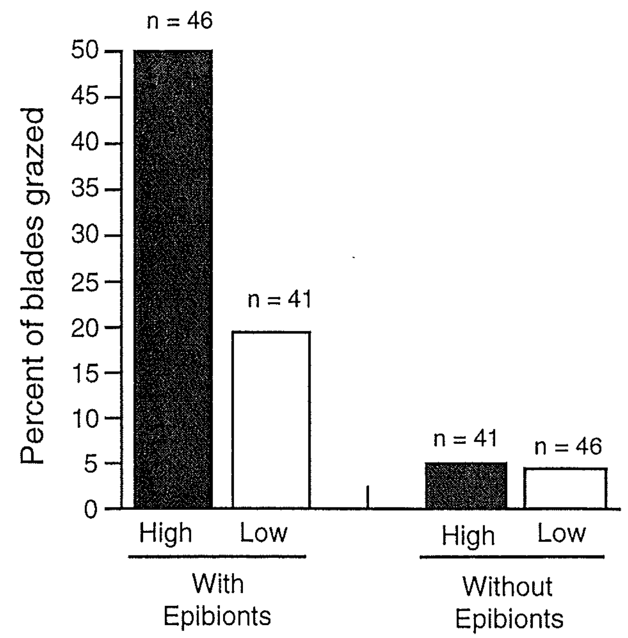

Figure 2. The effect of epibionts and leaf position (high or normal vs. low or reversed; see Figure 1) on parrotfish grazing on *Thalassia testundinum.*

or absence of parrot fish grazing in the blade sections with and without epibionts. Nine blades with epibionts oriented up and four blades with epibionts oriented down had been completely removed by the parrotfish and were not used in analysis. We used Chi-square tests to analyze differences in grazing occurrence between epibiont regions and non-epibiont regions and between upper and lower portions of blades. This analysis assumes that each occurrence of grazing is independent of other grazing events, an assumption not guaranteed in our experimental design. Ideally, each blade would have been placed individually in the reef.

Results

Areas of the blades with epibionts were grazed more than areas without epibionts (Chi-square = 27.46, df = 1, $p < 0.001$). Upper portions of blades with epibionts were grazed more than lower portions of blades with epibionts (Chi-square = 12.37, df = 1, $p < 0.01$). Parrotfish preferred to graze on blades with epibionts on the upper portion, followed by blades with epibionts on the lower portion, and then blades without epibionts (Figure 2).

Discussion

As predicted, parrotfish do not randomly graze on seagrass blades, nor do they only eat the top, most accessible parts of the blades. Instead, both the presence of epibionts and their height affected the height at which the fish grazed. Parrotfish prefer to graze on regions of blades with epibionts, and they foraged more frequently on blades with epibionts near the top of the blade than on blades with epibionts near the base of the blade. A possible explanation for this trend is that epibionts at the top are more easily detected and grazed upon and therefore preferred to epibionts lower down. When given the choice between low, epibiont-covered regions of grass blades and high regions of grass without epibionts, the fish chose the former. Probably, the nutritional benefits of the epibionts far outweigh any costs that are attached with foraging lower on the blade.

The Effect of Disturbance on Grazing of *Thalassia testudinum*

Zoë M. McLaren and Ashley C. Brown

Abstract: Ocean disturbance caused by wave action and surge can create an inhospitable habitat for herbivorous fish, potentially providing a refuge for plant species. Seagrass (*Thalassia testudinum*), an important primary producer on coral reefs, may benefit from reduced grazing pressure in such habitats. Increased disturbance should decrease grazing pressure by parrotfish by reducing maneuverability in seagrass beds. To evaluate differences in herbivory on seagrass in Discovery Bay, Jamaica, we placed seagrass blades in a calm, sandy seagrass bed, and at the reef crest where waves were breaking. There was no significant difference in area lost to grazing between the two areas. There was, however, much more variation in herbivory levels in the high disturbance habitat than the low disturbance habitat. Disturbance may be less important in influencing herbivory levels than proximity to patch reefs where grazers such as coral reef fish and sea urchins reside. According to optimal foraging theory, scarce and patchy resources in the disturbed habitat may cause individuals to graze more intensely on individual seagrass patches. Long term effects of disturbance may alter the key role seagrass plays in tropical marine ecosystems.

Key Words: coral reef ecology, herbivory, seagrass, wave action

Introduction

Ocean disturbance caused by wave action and surge can create an inhospitable habitat for herbivorous fish, potentially providing a refuge for plants. These refuges may be particularly important for species such as seagrass (*Thalassia testudinum*) which faces heavy herbivory pressure from reef fish, sea urchins and sea turtles. Therefore seagrass growing in habitats disturbed by wave action and surge that make it difficult for fish to maneuver may benefit from lower fish grazing (Lewis 1986, Foster 1987).

In Discovery Bay, Jamaica, seagrass beds are found in both wave-disturbed and undisturbed areas; however little is known about the relative grazing pressures in these habitats. We hypothesize that disturbance will affect the level of herbivory on sea grass in these distinct habitats. Specifically, we predicted that seagrass located at the reef crest where waves are breaking will have reduced levels of herbivory by coral reef fish compared with seagrass located in the calmer habitats of the sandy back reef.

Methods

Seagrass blades were haphazardly collected from a sand bed 150 m north from the Discovery Bay Marine Lab, Jamaica, and cut to a standard length of 15 cm. Five replicate experimental units, each consisting of 10 grass blades attached to weights, were placed in each habitat, disturbed and undisturbed. The undisturbed habitat was located in the calm, sandy back reef about 100 m north of the Marine Lab, where there was only mild surge (Figure 1). The disturbed habitat was located 3 m south of the reef crest, where waves were breaking. Replicates were placed haphazardly at least 1 m apart in the two treatments from 10 am on 25 February until 10 am 26 February, a day that was breezy but quite calm. We used a Wilcoxon 2-Sample Test to compare the area lost to herbivory between the two habitats due to unequal variances (as determined by a Levene's test) in the treatment groups.

Results

There was no significant difference in

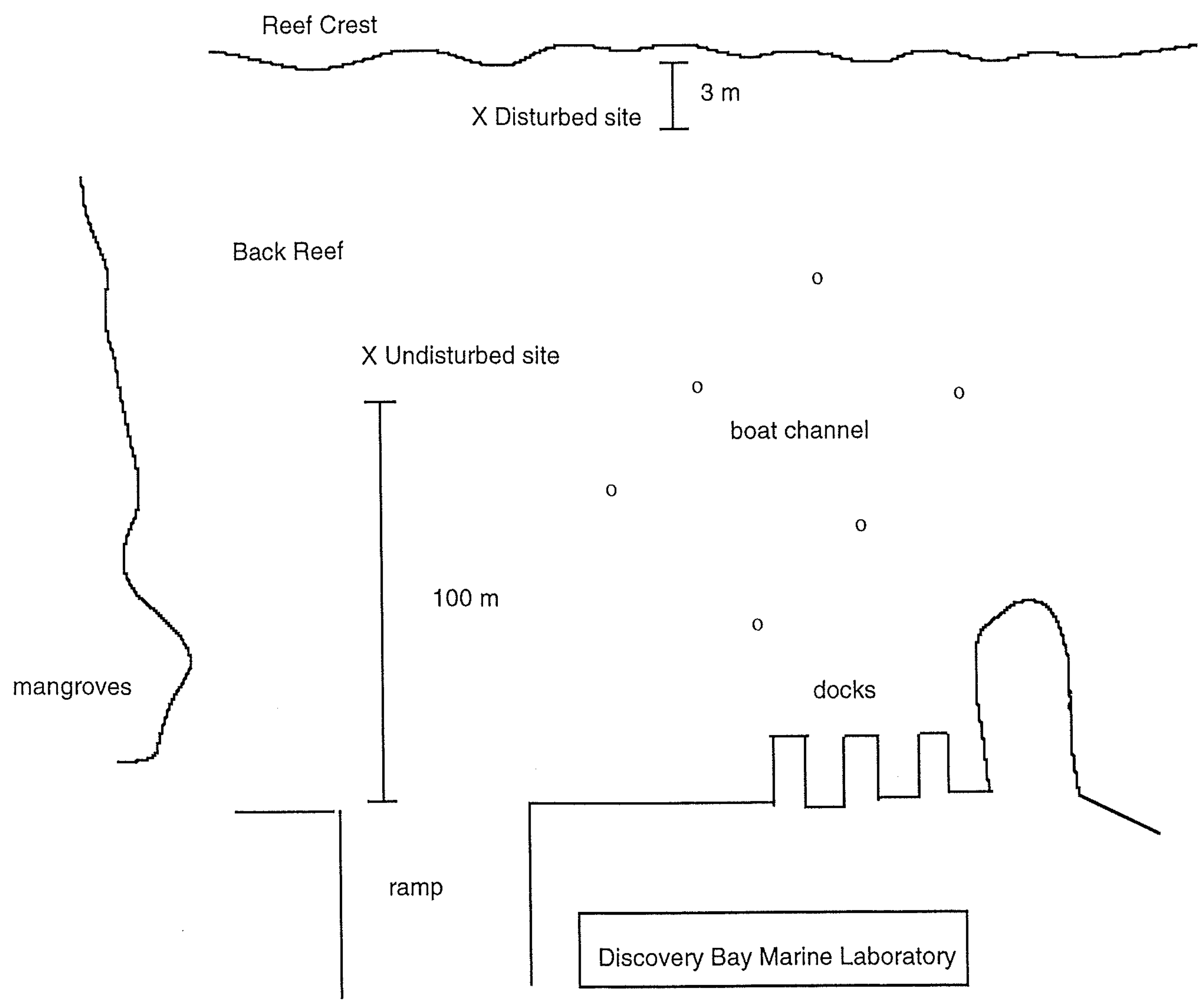

Figure 1. Map of disturbed and undisturbed sites in Discovery Bay, Jamaica. (Drawing is not to scale.)

area lost to grazing between disturbed and undisturbed treatments (S = 29, Z = 0.21, p = 0.83). However, the variances between treatments were significantly different (F = 6.22, DF = 1, p = 0.04). The level of herbivory was consistently low in the undisturbed treatment across replicates, and was highly variable among replicates for the high disturbance treatment (cm^2 loss mean ± SD: low disturbance = 0.71 ± 0.06 cm^2, high disturbance = 13.81 ± 24.3 cm^2). In the high disturbance treatment, three replicates had little to no herbivory, one was strongly impacted by parrotfish herbivory (12.1 cm^2 loss) and another was severely impacted by urchin grazing (56.3 cm^2 loss) (Figure 2). Parrotfish were responsible for all other grazing.

Discussion

Although there was no difference in mean herbivory levels between disturbed and undisturbed habitats, our results point to an interesting difference in the variation of herbivory between replicates within both treatments (Figure 2). Though it appears that disturbance habitats do sustain somewhat less parrotfish herbivory, wave action and surge

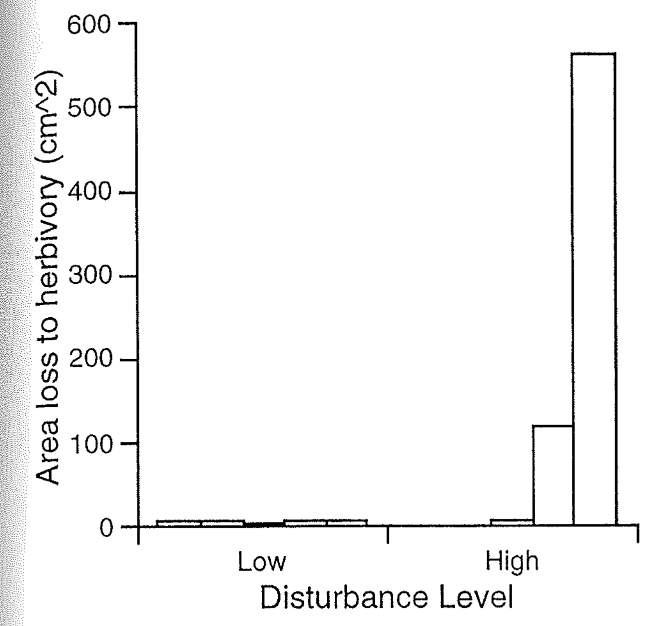

Figure 2. Seagrass area loss to herbivory (cm^2) by parrotfish and urchins. Each bar represents total loss for a replicate of 10 leaves 68 cm^2 each. Two replicates in the high disturbance treatment had no losses to herbivory.

occurring during this study did not seem to discourage grazing by either parrotfish or sea urchins. However, when seas are rougher, grazing near the reef crest may be more difficult or impossible.

In addition to disturbance, our results suggest two other factors that may affect a grazer's ability to reach, and therefore graze on, seagrass beds: the proximity to shelter, and the animal's mobility. First, because the home range of many grazers, specifically reef fish and sea urchins, is centered around a reef, herbivory rates may be affected both by seagrass proximity to patch reefs (Hay et al. 1983), and grazer mobility. The disturbed site was considerably closer to coral reefs than the undisturbed site, which may explain sea urchin grazing in one replicate. Parrotfish are much more mobile animals, and seem to travel longer distances from shelter to forage in the undisturbed seagrass bed flats further from the reef (personal observation).

Alternatively, according to optimal foraging theory, when resources are scarce and patchy, animals will spend more time foraging at a particular patch, even if food quality is low. In the undisturbed site, where seagrass is very abundant, grazers would spend less time at each patch, resulting in the low observed herbivory rates per seagrass blade. However, in the disturbed site, where seagrass was scarce, grazers would forage more at each individual plant. Additionally, in patchy environments, sea urchin hunger levels can induce urchins to eat more low quality resources (Cronin and Hay 1996).

Our findings suggest that a combination of factors including disturbance level determine optimum seagrass habitat. While seagrass in an undisturbed habitat was subject to an even rate of herbivory, seagrass in the disturbed habitat risked complete decimation of the blades. The combination of factors that provide optimum habitat for seagrass growth also may include nutrient and light availability. Further studies could focus on how the growth rate in each habitat influences seagrass blade regeneration rate. If global warming increases ocean storm activity, this could influence the availability of undisturbed habitat for seagrass growth and thus alter the key role seagrass plays in tropical marine ecosystems.

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